Meeting DOE Needs for Beryllium Real-Time Monitoring: A Path Forward

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INTRODUCTION

DOE's *Chronic Beryllium Disease Prevention Program Rule, 10 CFR Part 850* was promulgated in December 1999 in response to the prevalence of chronic beryllium disease (CBD) among the DOE workers. The Rule requires beryllium surface and air monitoring to determine health risk and the effectiveness of mechanisms used to minimize or eliminate that risk. Current laboratory approaches involve significant delays and cost. The DOE has a compelling need for "real-time" instrumentation to monitor and control beryllium exposures to workers, to significantly speed up production times, and to save millions of dollars in analytical costs annually. This white paper defines the problem, articulates an approach to solving the problem, identifies the needed resources and schedule, and seeks senior management endorsement and direction.

PROGRAM OBJECTIVES

Program objectives are summarized into four major areas: improved worker and public protection, improved productivity, characterize contamination migration, and evaluate legacy areas.

Improved worker and public protection

Basis for engineering/administrative controls/PPE: Many of the tasks that contribute most to beryllium worker exposure are of short duration and cannot be identified for control without a real-time monitoring instrument. Real-time beryllium monitoring would provide the ability to identify where additional engineering or administrative controls can be applied to provide the best benefit.

Timely feedback to workers: Exposures resulting from process malfunctions or incorrect practices may continue unchecked until analytical results of scheduled monitoring identify the problem. Current beryllium measurement methods take days to weeks to obtain results. This is in stark contrast to current radiation measurement methods that are virtually instantaneous. Beryllium samples must compete with other samples for priority

for analysis that contributes to analysis lag time. Real-time beryllium monitors would provide the ability to remove workers when an out-of-limit situation occurs.

Improved Productivity

Movement of materials: Measurement of beryllium surface contamination levels is required on parts moving through a process in order to demonstrate that control boundaries are maintained. As mentioned above, under the best conditions processes are put on hold for a day while waiting for surface analysis results. The process cost savings of having real-time beryllium monitoring capability is estimated to be 3-4 person-years of effort per year per site.

Similarly, the cost savings in hold time of having this capability to quickly verify that welding or lathe enclosures are clean, to determine personal protective requirements prior to maintenance activities, and to characterize beryllium contaminated spaces and facilities would be significant.

Personnel efficiency: Beryllium monitoring used to verify contamination control is a key step in the flow of beryllium work. Waiting for laboratory results puts the process on hold which lengthens production times and increases production costs. Real-time beryllium monitors would provide timely feedback to workers and knowledge of how and why beryllium particles becomes airborne, allowing them to improve their work practices.

Also, lack of real-time airborne beryllium monitoring may impact process efficiency due to possible overprotection of workers. Workers often are required to use added personal protective equipment such as respirators because airborne levels at the time of the operation are unknown. This can decrease worker personal productivity by approximately twenty percent.

Reduced analytical laboratory costs: The cost of beryllium analysis is staggering. At least three DOE sites spend $2 million per year for beryllium analysis. Analysis costs and limited laboratory capacity are restricting the number of beryllium samples that are collected which hampers characterizing beryllium hazards in the workplace.

Characterize Contamination Migration

Beryllium control requires a great deal of surface monitoring. The DOE Rule requires surface monitoring to determine housekeeping effectiveness, to characterize the contamination level of former beryllium areas, and to determine the contamination level of equipment and products slated for release from a beryllium area. Many DOE sites use surface monitoring to ensure that contamination does not migrate outside beryllium areas to areas where non-beryllium workers are located.

Evaluate Legacy Areas

The DOE Rule also requires monitoring to characterize the contamination level of legacy beryllium areas and facilitate proper D&D. Areas can be large and complex. Real-time monitoring would provide a basis for prioritizing cleanup efforts, selecting appropriate techniques and personnel protection, and verifying the adequacy of cleanup.

STATUS OF TECHNOLOGIES

There has been no coordinated effort to develop practical and effective real-time beryllium monitoring instrumentation in spite of the great need for it as demonstrated in the above discussion. Individual attempts at fulfilling this need have so far resulted in unvalidated, expensive, and bulky instrumentation that has proven unacceptable.

Ten companies or research organizations have developed real-time beryllium monitoring instruments or methods. Methods include laser induced breakdown spectroscopy (LIBS), microwave induced plasma spectroscopy (MIPS), surface-enhanced raman scattering (SERS), colorimetric wet chemistry field kits, anodic stripping voltammetry (ASV), and aerosol time-of-flight mass spectroscopy (ATOFMS). The cost range for those instruments that are commercially available is $75K to $400K. Most of the instruments are bulky; and while they may be transportable, their utility is limited by their size and cost per instrument. Two of the instruments are in the technology development stage, three are in the prototype stage, and one company is out of business. This leaves four instruments that are commercially available. Of these four, one is only a qualitative method, one has never been tested with beryllium, and the other two cost at least $300K and are very large. No instruments have been validated.

PROPOSED BeRTM DEVELOPMENT AND IMPLEMENTATION PROCESS

In order to meet the goal of having commercially available verified instruments, we envision four key steps or phases. Phase I is the initial start-up where a blue ribbon panel of experts is established that finalizes instrument criteria and selects three to four cost effective technologies. Phase II establishes a contractor to develop a beryllium aerosol laboratory, to partner with technology developers in order to meet instrument performance criteria, and make test materials. In addition, a mechanism to certify test materials is established. Phase III is the verification phase where a qualified test bed is complete and instruments are verified using the Environmental Protection Agency Environmental Technology Verification program as a model. Phase IV is the final phase where instruments are manufactured. Figure 1 illustrates an estimate of schedule. No funding is needed for Phase I and IV. Phase II is estimated at $1.5-2.0M for facility development and $2-3M per year operating costs. Phase III costs are minimized to approximately $0.5 to 1.0M by requiring the instrument manufactures to supply the instruments.

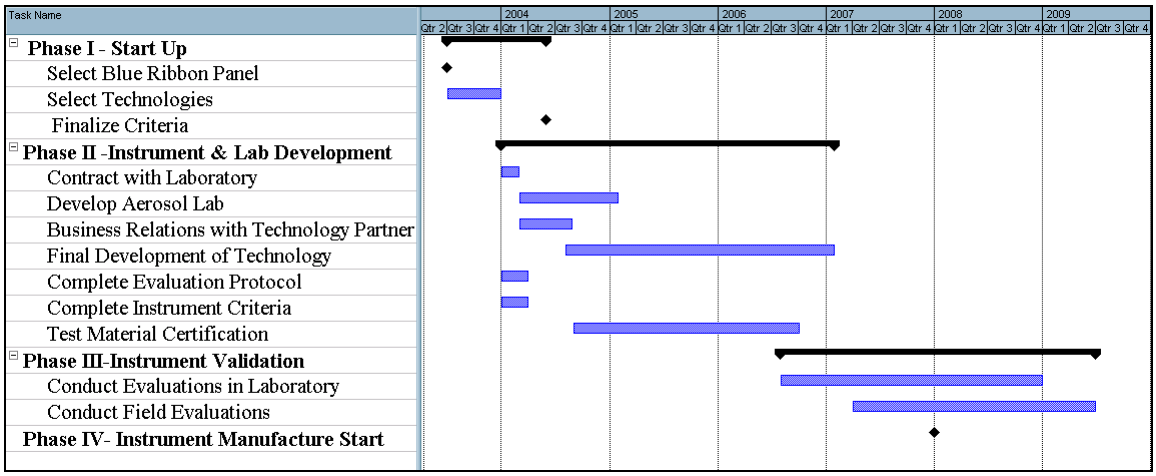

FIGURE 1 – Proposed schedule

CONCLUSIONS AND RECOMMENDATIONS

Safe, cost-effective, and timely beryllium production requires the development, validation, and field availability of a real-time method of measuring airborne and surface beryllium contamination. Cost savings that would be generated by using such instrumentation are estimated to be millions of dollars per year per site. Almost ten years of uncoordinated effort has failed to provide us with useful instrumentation, demonstrating the need for a focused effort.

Given DOE's mission requiring the continued use of beryllium, we recommend that DOE take the lead in managing real-time beryllium instrumentation development, validation, and availability to the field. We request that senior management endorse this approach; provide appropriate interagency agreements (potentially involving NIOSH, DoD, NIST, EPA, and OSHA) to accomplish the needed work; and assist in providing needed funding, staffing, and facilities.

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